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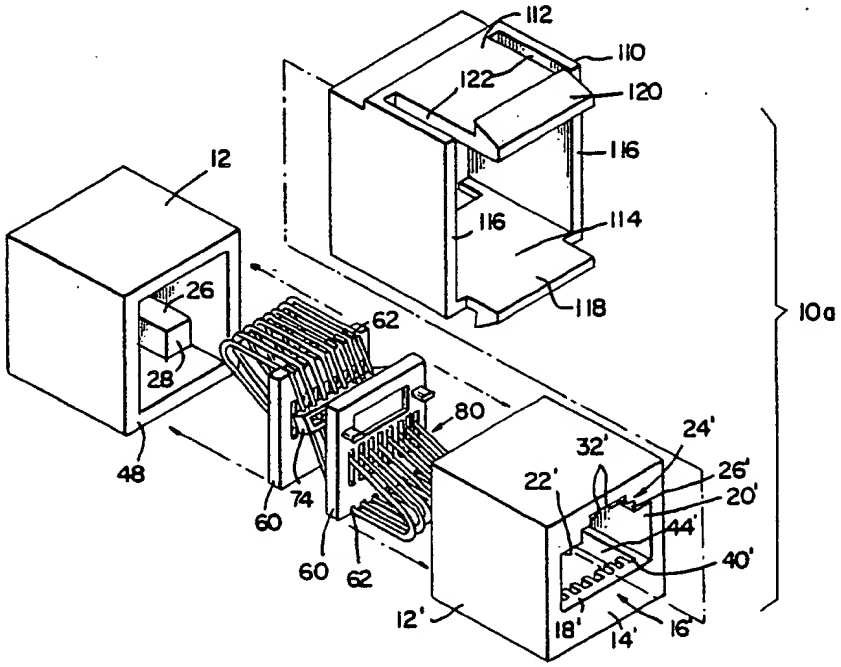

(57) Abstract

An electrical coupler (10a, 10b) for interconnecting two modular telephone plugs (150) includes a housing (12, 12') having two mating faces (14, 14') with openings (16, 16') for receiving the two modular telephone plugs (150). The terminals (80) within the coupler comprise wire (78) which is formed to include two resilient portions (90, 100) disposed adjacent to the modular plug openings (16, 16'). A terminal subassembly is disclosed wherein a plurality of solid conductors (78) are aligned side-by-side and a web (70) is molded over the span of wires (78) such that when the wires (78) are cut to the desired length, the integrally molded web (70) forms a terminal subassembly for ease of installation of the terminals within the housing (12, 12').

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MODULAR PLUG COUPLER AND METHOD OF FORMING SUCH A COUPLER

The invention relates to method for forming a coupler of the type for interconnecting two modular plugs.

Couplers used for interconnecting two multiconductor telephone cables wherein each of the multiconductor cables includes a modular plug interconnected to the multiconductor cable are useful as a means for lengthening or splicing multiconductor cable. Such couplers are known in the art as taught by such references as U.S. Patent 4,153,327; U.S. Patent 4,268,109; U.S. Patent 4,273,402; U.S. Patent 4,367,908; U.S. Patent 4,379,609; and U.S. Patent 4,460,234. Most of these references teach using solid conductor wire formed in a variety of configurations to form two sets of resilient contacts such that the single wire can be used to interconnect the blade type contacts of two modular plugs. However, none of these references teach an inexpensive method for inserting the terminals within the housings, as all of the terminals are formed as individual contact members.

References such as U.S. Patent 4,224,485; U.S. Patent 4,295,702; and U.S. Patent 4,406,509 teach inserts which hold a plurality of wires or contacts to the insert such that the insert can be installed within a housing for interconnection to a modular plug. In none of these references, however, is it taught to integrally mold the insert or web around the terminals for ease of manufacturing and ease of handling the terminals as a subassembly. Rather the wires or terminals are individually inserted within the inserts.

A prior art coupler which includes a molded web over the terminals is shown in Figures 1A, 1B and 2. However, this coupler does not have a small front mating interface which makes it convenient and useable for a panel mountable electrical coupler. Rather the coupler includes like housing halves which makes the overall housing twice as large as a coupler which is inline. For panel mount purposes, the interface dimensions should be as small as possible in order not to waste panel space.

It is an object of the instant invention to design an electrical coupler which includes an improved method of handling the terminals which lowers the cost of the coupler.

It is an object of the instant invention to design an electrical coupler which includes a molded web over terminals which increases the ability to handle the terminals.

It is a further object of the invention to design such a web in which a minimum sized web is used.

It is a further object of the invention to design such a web in which the web will not move longitudinally along the terminal length after the molding process.

Such a coupler is formed by pulling solid wires from a reel and aligning them to form a plurality of side-by-side wires and thereafter deformed transverse to their length, and molding an insulative and integral web over the deformation and over the span of wires encapsulating the wires therein. The webs are molded on longitudinal centerlines such that the length between the webs is the desired terminal lengths. The wires are then sheared midspan of the webs to define an integral web which includes a plurality of wires extending from each end of the web. The ends of the wires are formed into the desired configuration and inserted into the housing.

Figure 1A is an isometric view of a prior art coupler.

Figure 1B is an exploded view of the coupler of Figure 1B.

Figure 2 is a cross sectional view through lines 2-2 of Figure 1A.

Figure 3 is an isometric view of an inline modular plug coupler consistent with the subject invention.

Figure 4 is an isometric view of a right angle coupler poised for receipt of two modular plugs.

Figure 5 is a view of the components of the inline coupler exploded away from each other.

Figure 6 is an isometric view of the terminal assembly.

Figure 7 is a cross-sectional view through lines 7-7 of Figure 5.

Figure 8 is an isometric view showing the components of the right angle coupler, as shown in Figure 4, exploded away from each other.

Figure 9 is a cross-sectional view through lines 9-9 of Figure 4.

Figure 10 is a diagrammatical view showing the method of formation of the terminal subassembly.

Figure 11 is an enlarged view of the insulative web which joins the plurality of terminals into the subassembly.

Figure 12 is a cross-sectional view through lines 12-12 of Figure 11.

Figure 13 is a cross-sectional view through the molding dies which would form the integral web.

Figure 14 is a cross-sectional view through lines 14-14 of Figure 11.

Figures 3 and 4 show inline and right angle couplers 10a, 10b, respectively, for interconnecting two multiconductor cables 164 such as multiconductor telephone cable having electrical plugs 150, typically referred to as modular plugs, electrically connected to each end of the multiconductor cable 164. Modular plugs of this type include housings such as 152 having a polarizing feature 158 with an integrally molded latch member 162 which is resiliently movable towards the housing 152 having latching surface 160. On the side opposite of the polarizing feature 158 is located a plurality of channels situated side-by-side, such as 154, with plate-like terminals 156 which stake through the insulation of the multiconductors to interconnect the conductor of the cable 164. Upon insertion of such plugs, the wire-like terminals of the coupler are aligned and reside in channels 154 to contact the terminals 156 for interconnection of the two plug members 150.

With reference now to Figure 5, the inline coupler 10a will be described in detail. The inline coupler 10a is comprised of two identical housing members 12 and 12' such that description of the one will suffice as a description of the other, bearing in mind that the views are such that the internal structure of each housing 12, 12' cannot be seen in the same figure. Thus, a

description of a feature to the housing 12 should be a sufficient description of an equal feature of the housing 12' and vice versa.

As shown in Figure 5, the housing 12' includes a front mating face 14' having a plug receiving opening 16' defined by a lower ledge 18', sidewalls 20', and an upper ledge 22'. Extending upwardly from the ledge 22' is an alignment and latching feature shown generally as 24' which is defined by two ribs 26' which flank the opening and two alignment lugs 30' (Figure 7) having inner sidewalls 32'. Extending downwardly from the lower ledge 18' are a plurality of channels 40' which extend downwardly in the same plane as the front mating face 14' and extend to the bottom wall 42', as shown best in Figure 7. Extending along both sidewalls of the housing 12' are two ribs 44' which extend rearwardly of the front mating face. As shown best in Figure 3, the inline coupler is profiled such that the plugs are insertable at an orientation 180° where one is rotated 180° with respect to the other such that the housings 12 and 12' are also rotated 180° with respect to the other. Therefore, housing 12, as shown in Figure 5, shows the rib 26 on the bottom whereas rib 44 would be at the top.

As shown in Figure 6, a terminal subassembly is included, the assembly being joined and held together by an integral web member 70 extending transversely of the terminals, the web being described in greater detail herein. The terminal subassembly 80 includes a section 82 which is commoned to both terminal sections, the first terminal section being formed by a radius 84 which extends into a leg 86, thereafter being formed through a radius 88 which reversely bends the terminals to form resilient contact portions 90 having free ends 92. The second terminal portions begin at the opposite end of the commoned section 82 and are formed through a first radius 94 to define a second leg 96 which is generally parallel with the first leg 86. The leg portions 96 are thereafter reversely bent through a radius 98 to form the resilient contact portions 100 having free ends 102.

Two terminal alignment plates 60, 60' are also included, each having alignment channels 62 extending along an edge thereof. The plates 60, 60' also include grooves 64 and 64' which extend completely through the plates and are aligned with each of the channels 62, 62'. Standoff feet 66, 66' are further included to space the plates within the housings 12, 12', respectively.

As shown in Figure 5, an outer housing 110 is further included having an upper wall 112, a lower wall 114, and sidewalls 116. The lower wall includes an integral stationary latch member 118 whereas the upper wall 112 includes a resilient latch member 120 being integrally formed with the upper wall 112 but being slotted as at 122 along sides thereof allowing the latch member 120 to be movable upwardly and downwardly relative to the upper wall 112.

The right angle coupler of Figure 4 will now be described with reference to Figures 8 and 9. The coupler shown in Figure 9 comprises substantially identical housings 12 and 12'', the only difference between housing 12'' and 12 being that the lower wall includes an opening 50 which is recessed from the back wall 48'' which does not exist on either housing 12 or 12'. Otherwise, the housing 12'' is identical to either housing 12 or 12''.

Referring now to Figure 9, the terminal assembly 180 is similarly configured with the integral web 170, encapsulating the plurality of wires to form a subassembly. However, the terminal subassembly 180 includes legs 186, 196 which are perpendicular to one another and include radiused portions 188, 198, respectively, defining resilient contact portions 190 and 200.

With reference now to Figures 10-14, the formation of the terminal subassemblies 80 and 180 will be described in greater detail. Referring first to Figure 10, a reel assembly 300 is shown comprising a plurality of reels 302 which would store the individual wire 78 in a rolled configuration. The wires 78 would then be threaded around guide rolls 304 and then further around guide rolls 305 to space the individual wires in the lateral centerlines into which the terminals need to be placed for the end subassembly. The wires overlap a molding assembly 306

which deposits the insulative material over the span of individual wires 78 to encapsulate the wires 78 into the web 70 or 170. The newly formed web 70 or 170 is then moved a distance "a" such that a new span of wires overlie the molding assembly 306 and a new insulative web 70 is formed thereover.

By encapsulating the wire 78 within the web 70, the wires are easily managed and the webs also allow for a registration for further manufacturing. For example, the desired distance between webs 70c and 70d is a distance "b". Moving the insulative web 70d a distance "a" away from the molding assembly 306 will register the new span of wires over the molding subassembly 306 such that the distance "a" between webs 70e and 70d is equal to the desired length between each of the webs, or such that "a" is equal to "b". The insulative webs 70 also allow for registration of the cutting tools such that the desired wire lengths "c" can always be properly maintained. In the preferred embodiment of the invention, the distance between successive insulative webs 70, that is the distance "b", will be the desired length of the wire for the terminal subassembly. Therefore, by cutting the span of wires at the lengthwise center between successive insulative webs, a terminal subassembly 80 can be formed with the proper length of terminals, the length being shown as "c" in Figure 10. Once the terminal subassemblies are formed with the desired lengths "c", each of the subassemblies can then be subjected to forming dies to further process the final subassembly 80 or 180.

With reference to Figure 13, the molding assembly 306 comprises upper and lower molding dies 308 which are movable towards and away from the wire 78 to overlie the wire for the molding process. The molding assembly 306 further comprises retractable upper and lower coining dies 312, 314 which are retractable relative to the upper and lower molding dies to coin the wire at a position integral with the web. Once the wires are coined, molten material is injected through a sprue such as 316 to fill the dies to encapsulate the wire. Retraction of the molding dies 308, 310 and coining dies 312, 314 leaves the webs integrally formed over the span of wires. It should be

understood that the coining dies could actually be a part of or integral with the the molding dies 308, 310.

Figure 11 best shows the integrally formed web in an isometric view where the insulative material encapsulates span of wires to form a terminal subassembly. By leaving the coining dies 312, 314 against the wire during the molding process, two channels 72 are formed above and below the span of wires, as shown in Figure 11 and Figure 12. Deforming the wire in some manner by the coining dies is an important aspect of the process as deforming the wire and then integrally molding the web around the deformation prevents the web from moving along the lengths of the wire. This is important for the registration of the webs as they relate to the lengths of the terminal subassemblies and further processes which use the webs as a registration. It should be understood, however, that the wires could be coined in two longitudinal places outside the exterior of the insulative web such that the web is prevented from sliding along the lengths of the wire by two areas of deformed wire exteriorly of the web.

Once the terminal subassemblies are fully formed into either the inline configuration 80 or into the right angle configuration 180, the final assembly of the coupler can be performed. Referring first to the inline coupler 10a, the assembly of the coupler begins with the addition of the plate members 60 and 60'. To install the plate 60' into the position as shown in Figure 5, the plate is inserted with the channels 62 directed towards the terminal subassembly and with the standoff feet 66' pointing outwardly. The plate 60' is inserted between the common portion 82 and between the free ends 92 and the plate in a somewhat tilted fashion such that the free ends are inserted into the elongate apertures 64'. When in the final position, the wires 78 are positioned within the channels 62' and the free ends of the terminals are positioned within respective elongate apertures 64'. The plate 60 is positioned into the other half of the terminal subassembly in a like manner such that the wires 78 are positioned within the channels 62 and the free ends 102 are positioned within the elongate apertures 64. As shown in Figure

5, the housings 12 and 12' can now be slidably received over the terminal subassembly 80 and over the two positioned plates 60 and 60' and the two housings can be fixed to each other by means such as an adhesive applied to one of the end walls 48. The outer housing 110 is then slidably received over the two assembled housings 12 and 12' and again adhesively held to a desired position over the two housings 12 and 12'. It should be noted that the outer housing 110 can be positioned relative to inner housings 12 and 12' in any desired position such that, if a panel mount coupler is desired, the outer housing 110 is pushed forwardly such that the end of the sidewalls 116 are flush with the front mating face 14' such that the coupler can mount to a face plate with the latches extending through the face.

Referring to Figure 7 shows the cross section of the inline coupler in a final assembled condition with the endwalls 48 and 48' in an abutting manner and the plates 60 and 60' in a position such that plate 60' abuts the two shoulders 20' and 46' formed by the two ribs 26' and 44', respectively. As shown, plate 60 resides within the housing 12 in a like manner. It should be noted that the terminals reside within the housing 12' such that the leg portion 86 abuts the floor 42' and the radiused portion 88 resides within the channels 40' while the terminal 92 resides within the elongate apertures 64' of the plate 60'. It should be noted that each individual terminal is retained within the housing at three positions, that is the channels 62' of the plate 60' positions the wires 78 at a position adjacent to the common portion 82, the terminal portion towards the front mating face is retained within the housing by the radius portion 88 being placed within the channel 40', while the free ends of the terminals reside in respective individual elongate apertures 64'.

The assembly of the right angle coupler is quite similar to that of the inline coupler, as shown in Figure 8. The plates are placed over the terminal subassembly in a like manner to the final position of that shown in Figure 8 and the first housing portion 12 is slidably received over the terminal in plate 60, as described with respect to the inline coupler. However, the housing portion 12'' must be placed orthogonally relative to the

housing 12' such that the lower wall of the housing portion 12'' abuts the back wall 48 of the housing 12. As shown in Figure 9, which is a cross-sectional view through the final assembly, the opening 50 provides the recess for the terminal subassembly to enter into the housing 12'' to position the leg portions 196 of the terminals adjacent to the floor 42''. Finally, a cap 52'' is required to enclose the back wall 48'' which includes standoff feet 54'' which abut and position the plate 60'' against the respective shoulders 28'' and 46''.

With the couplers so assembled, the couplers 10a and 10b can be used to interconnect two modular plugs such as 150 as shown in Figures 3 and 4. When the plug is inserted within the opening 16, the resilient portions 90, 100; 190, 200 are aligned with the channels 154 and thus ultimately with the blade terminals to interconnect the two plugs 150. Further insertion causes the latch 162 to be cammed downwardly until the shoulders 160 catch upon surface 34 (Figure 7) thereby latching the plug within the coupler.

The invention which I have have just described by way of the figures is the preferred embodiment of my invention but should not be taken to limit the scope of the invention; the appended claims being reserved to that end.

CLAIMS

1. A method of forming a terminal subassembly 80 for receipt in an insulative housing (12, 12', 12''), the method including the steps of:

pulling solid wires (78) from a reel (302) and aligning them to form a plurality of side by side wires (78);

deforming a portion of the wire (78);

molding an insulative material over at least a portion of the wires, to form an insulative web (70) over the wires (78) proximate to the deformation, thereby defining a terminal subassembly (80);

shearing the wires (78) to form two free ends; and

forming the wires (78) into the desired configuration.

2. The method of claim 1 wherein after the molding step, the wires are deformed at a position where the insulative web (70) will be placed to encapsulate the deformation within the web (70).

3. The method of claim 2 wherein the deformation is caused by coining the wires (78) transversely of the wire (78) length.

4. The method of claim 1 wherein prior to the molding step, the method includes the further step of coining the wires (78) in a direction transverse to their length to change the cross sectional shape of the wires (78).

5. The method of claim 1 wherein the integral web (70) is molded to span all of the wires (78) transversely of their length.

6. The method of claim 1 wherein the molding step includes the step of placing upper (308) and lower (310) die members in a surrounding relationship to the wires (78) and injecting the molding material therein.

7. The method of claim 1 wherein the molding step, prior to the injection step, further includes the step of forcing a coining die (312, 314) against the span of wires (78) such that the wires (78) are deformed and the molded web (70) conforms around the deformation to affix the wires (78) within the web (70).

8. An electrical coupler (10a, 10b) for electrically interconnecting two electrical plug members (150), wherein the coupler (10a, 10b) comprises:

an insulative housing means (12, 12' 12,'') comprising two mating faces (14, 14', 14'') having openings therein for reception of the electrical plug members (150);

a terminal subassembly (80) comprising a plurality of electrically conductive terminals where each terminal comprises a commoning section (82) intermediate two resilient contact portions (90, 100, 190, 200), each resilient contact portion comprising a free end (92, 102, 192, 202) reversely bent about a leg portion (86, 96, 196, 206), the terminal member being disposed within the housing means (12, 12', 12'') with the resilient contact portions (90, 100, 190, 200) disposed adjacent to the mating faces (14, 14', 14'') of the coupler (10a, 10b), the resilient contact portions (90, 100, 190, 200) being resiliently movable towards a base wall (42, 42', 42'') within the housing means (12, 12', 12'') upon reception of a plug member (150), and further comprising plate portions (60, 60', 60''), with each plate portion (60, 60', 60'') being disposed adjacent to the resilient contact portions (90, 100, 190, 200) and parallel with the respective mating face (14, 14', 14''), the plates (60, 60', 60'') having elongate apertures (64) therein for receiving the free ends (92, 102, 192, 202) of the terminals (80) and retaining them in lateral alignment.

9. The coupler (10a, 10b) of claim 8 wherein the plates include at an edge thereof channels formed transversely of the plates which overlie the terminals to position said terminals against respective base walls in a laterally spaced arrangement.

10. The coupler (10a, 10b) of claim 8 wherein the terminal subassembly (80) is formed by any of the methods of claims 1-7.

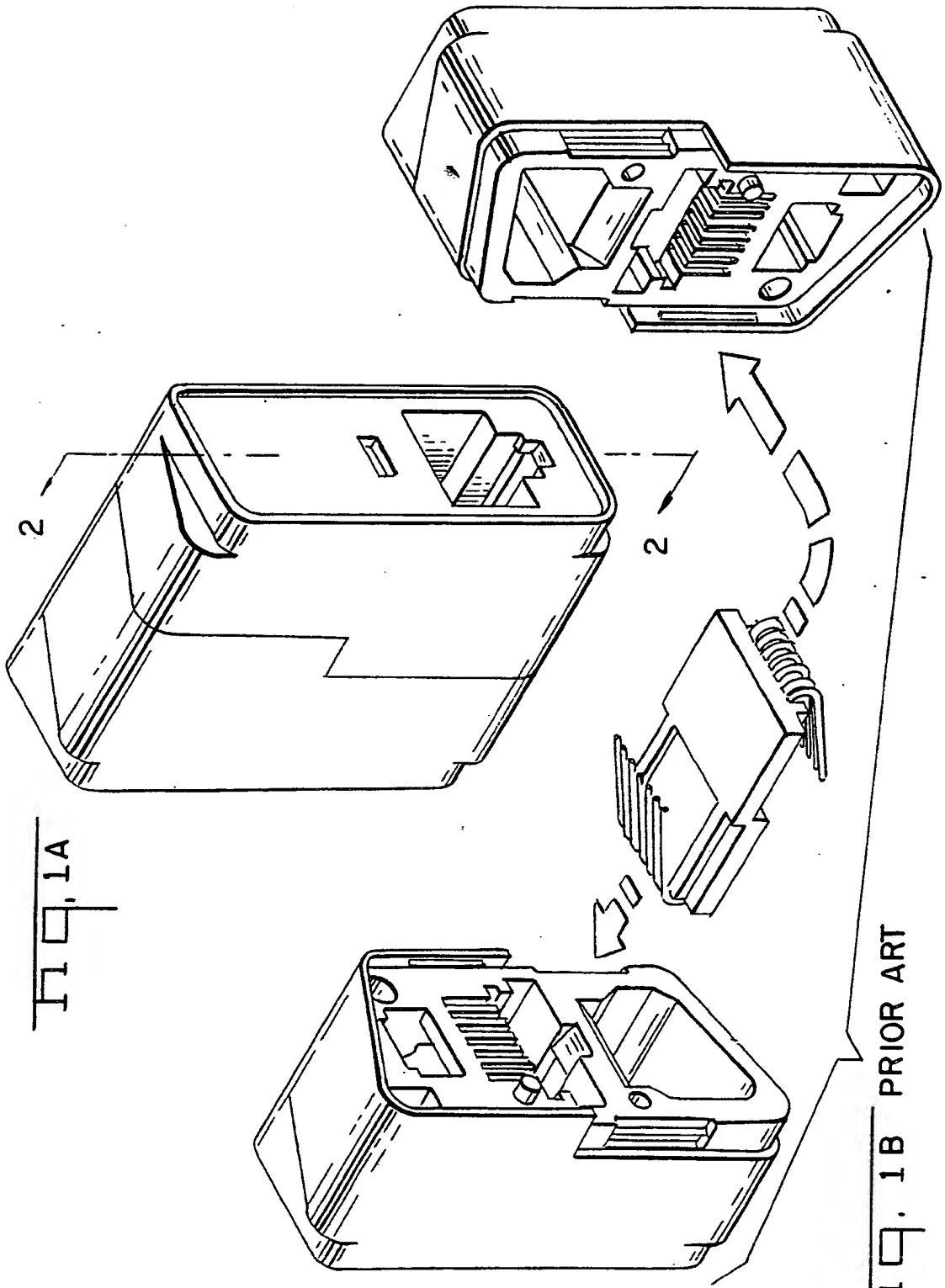
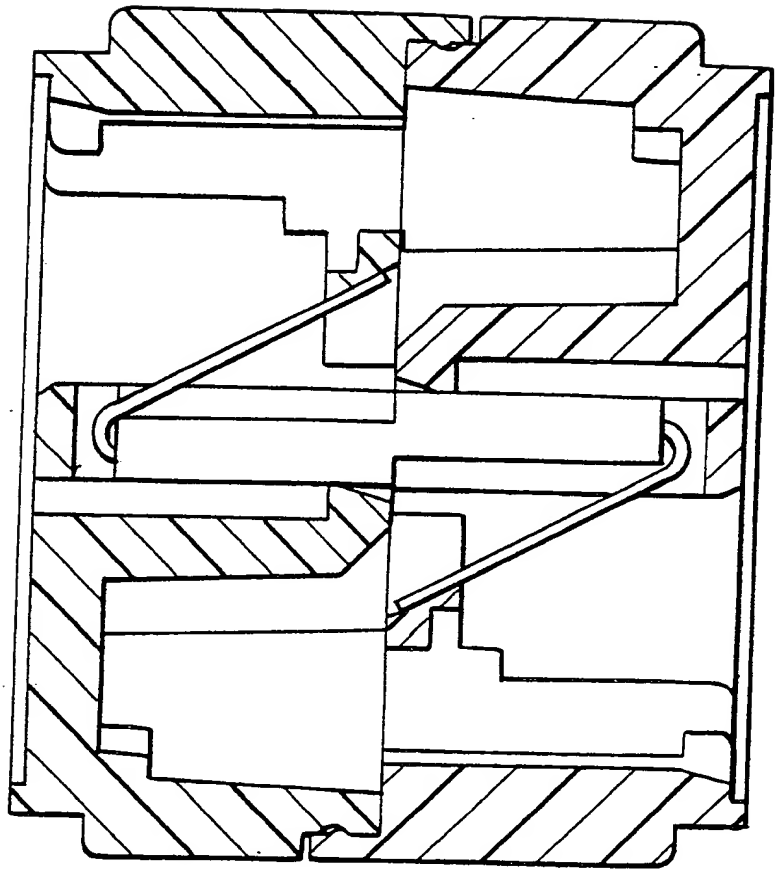


FIG. 1A

FIG. 1B PRIOR ART



PRIOR ART

FIG. 2

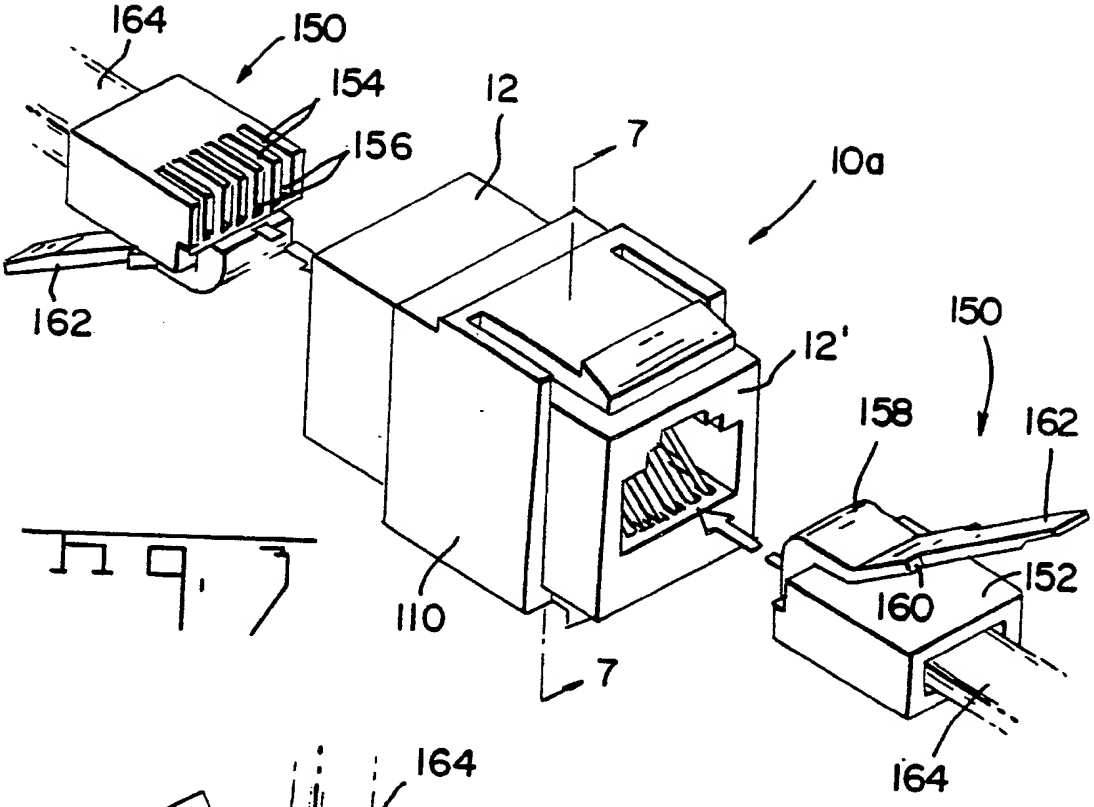

164
150
154
156
12
7
10a
162
12'
150
158
162
160
152
110
7
164

Fig. 7

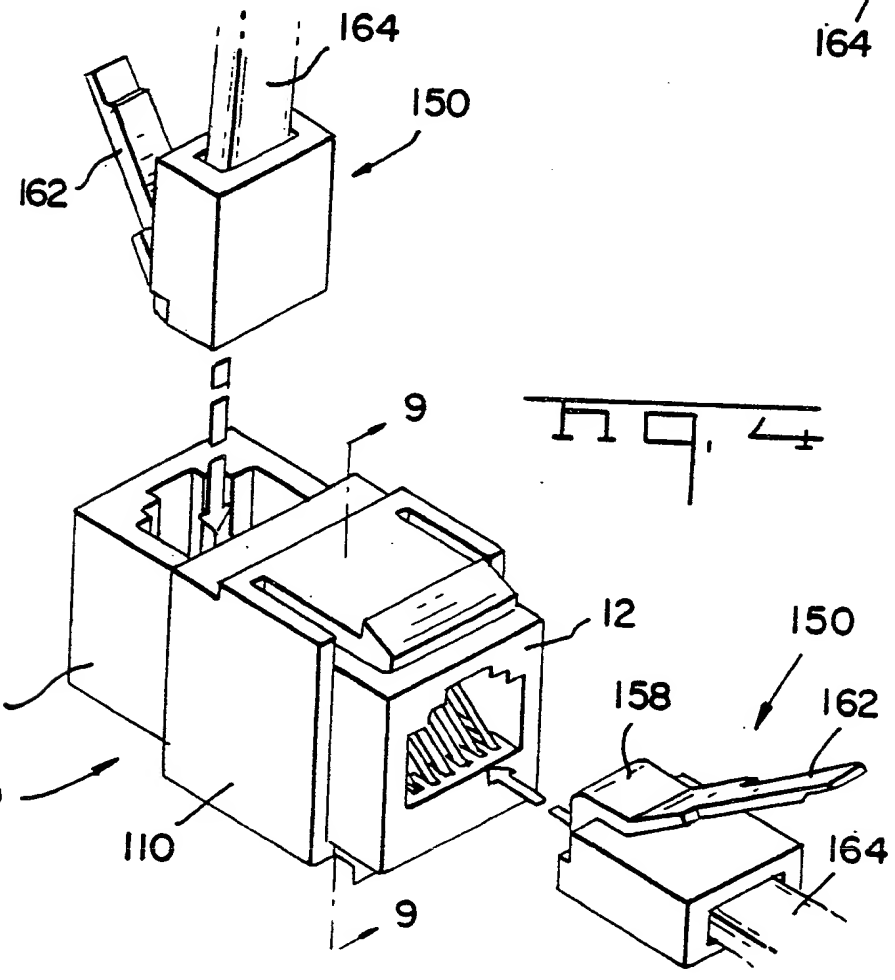

164
150
162
9
12
150
12"
158
162
10b
110
164
9

Fig. 4

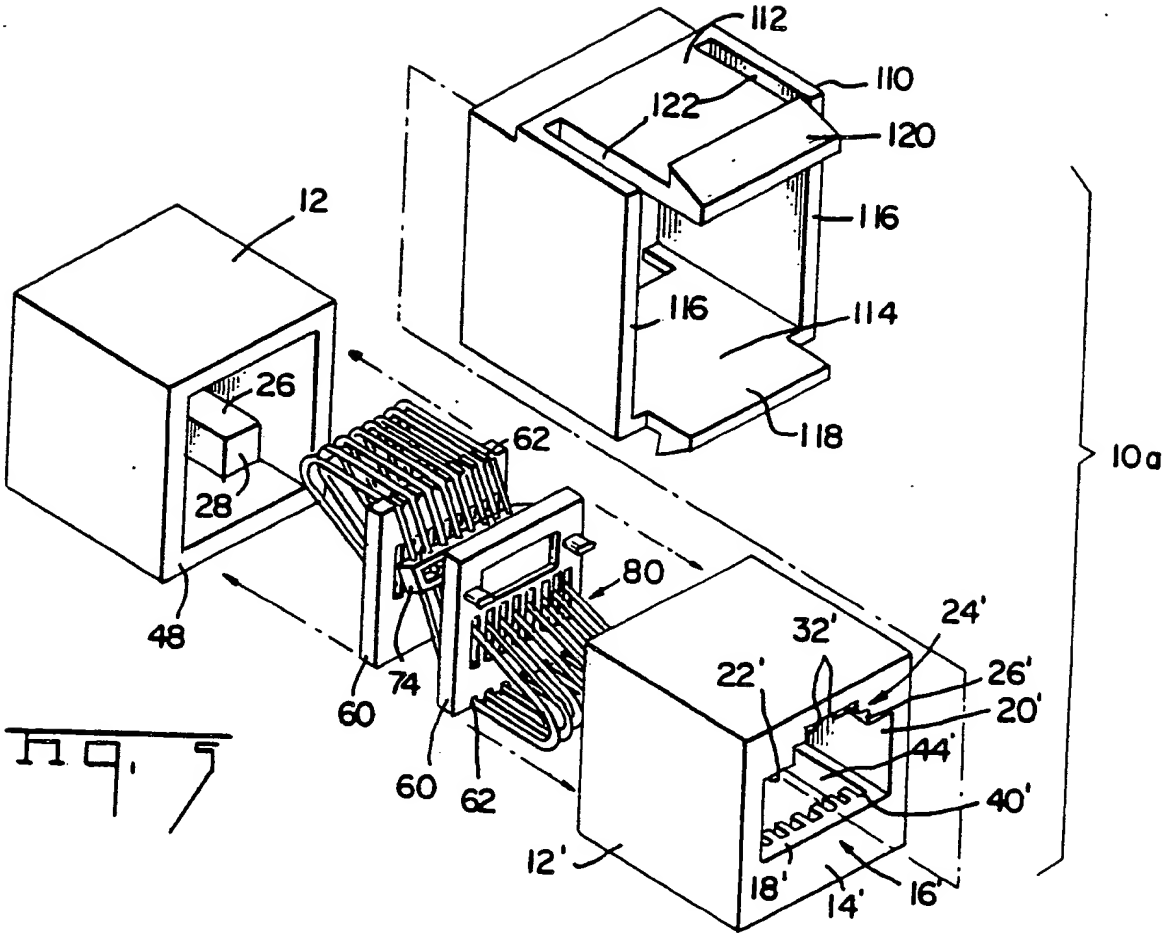
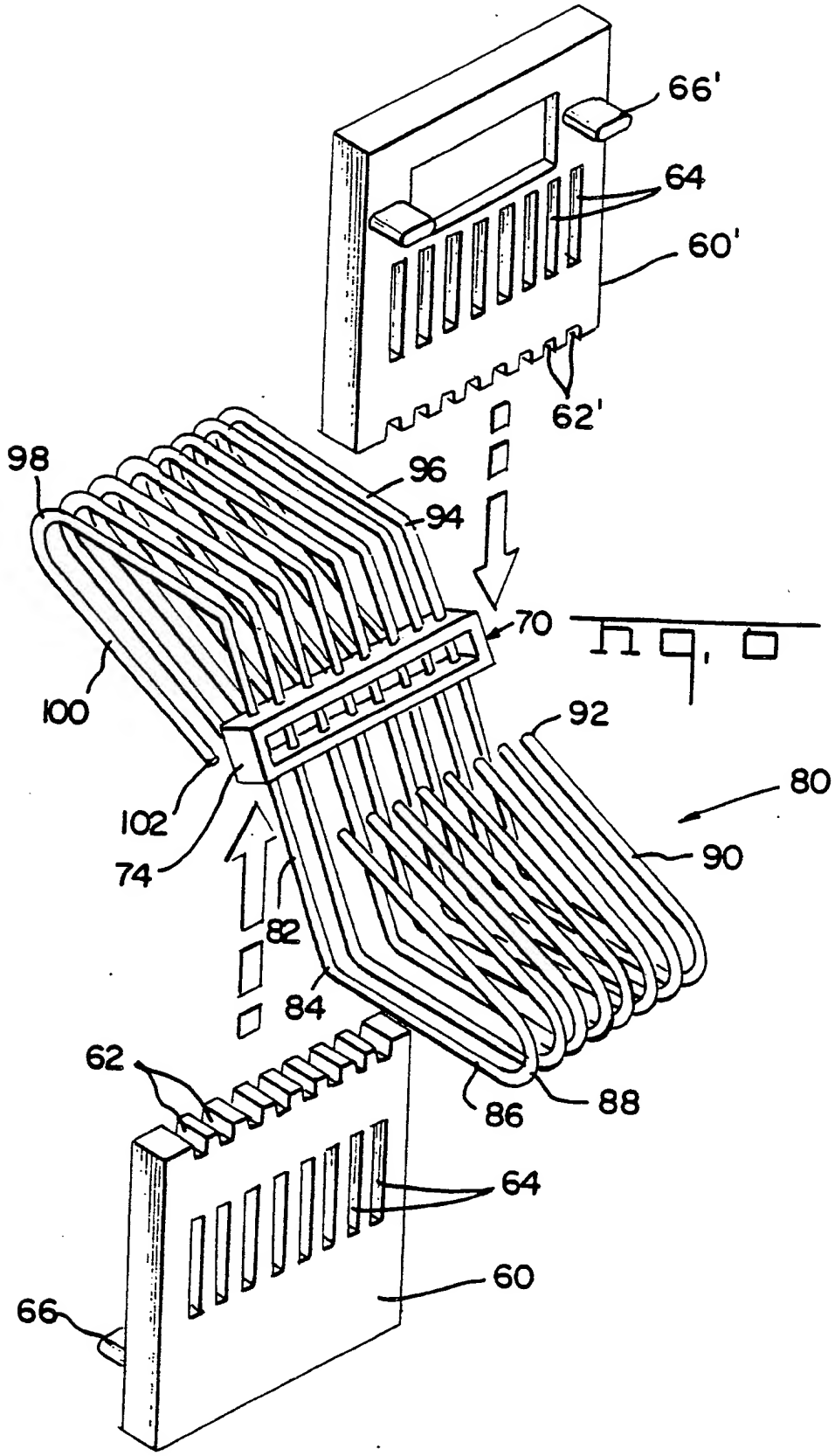

112
110
122
120
12
116
116
114
26
62
118
10a
28
80
48
24'
32'
22'
26'
20'
74
60
44'
60
62
40'
12'
18'
14'
16'

Fig. 5


66'
64
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98
96
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92
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102
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86
88
64
60
66

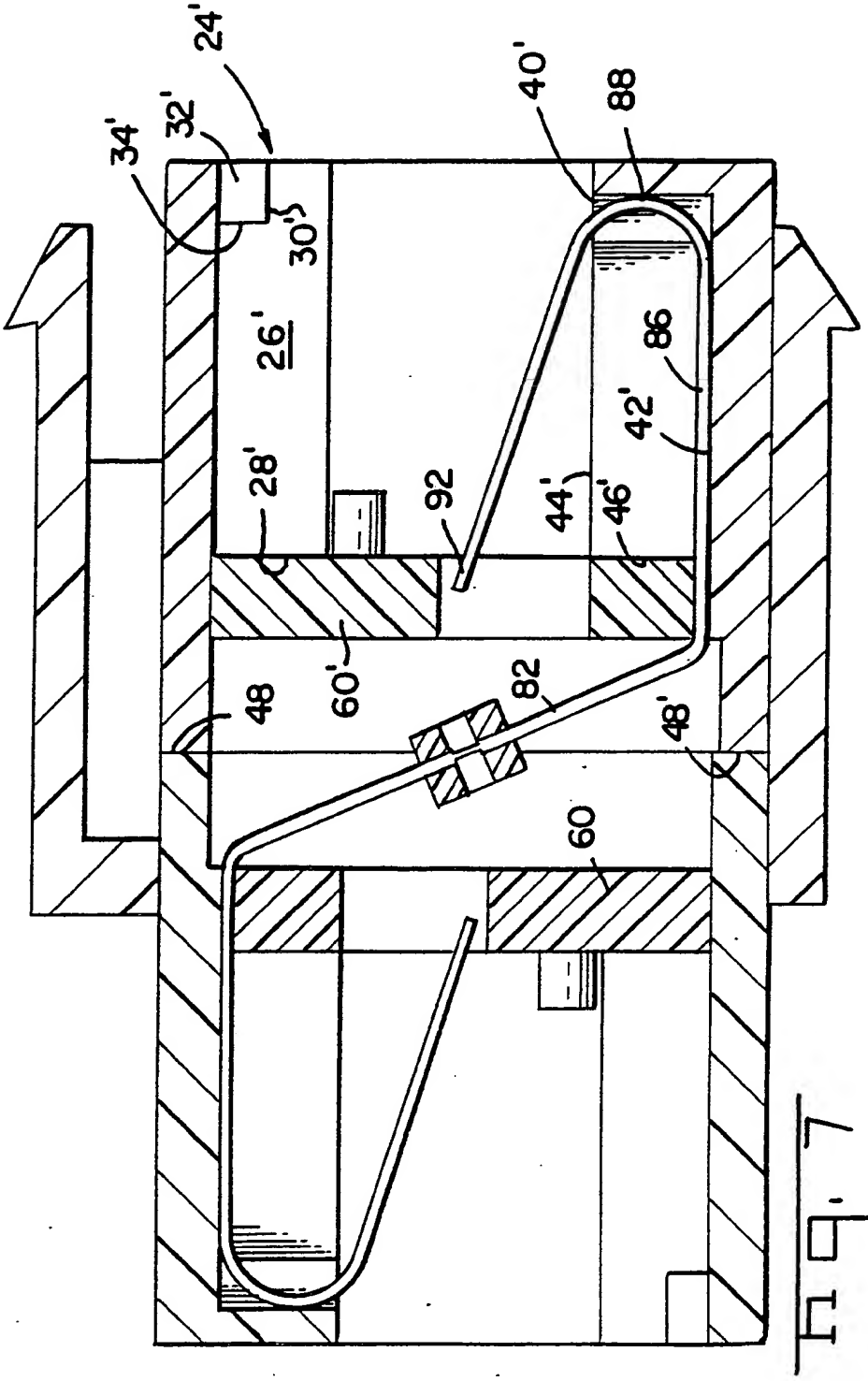


Fig. 7

Fig. 6

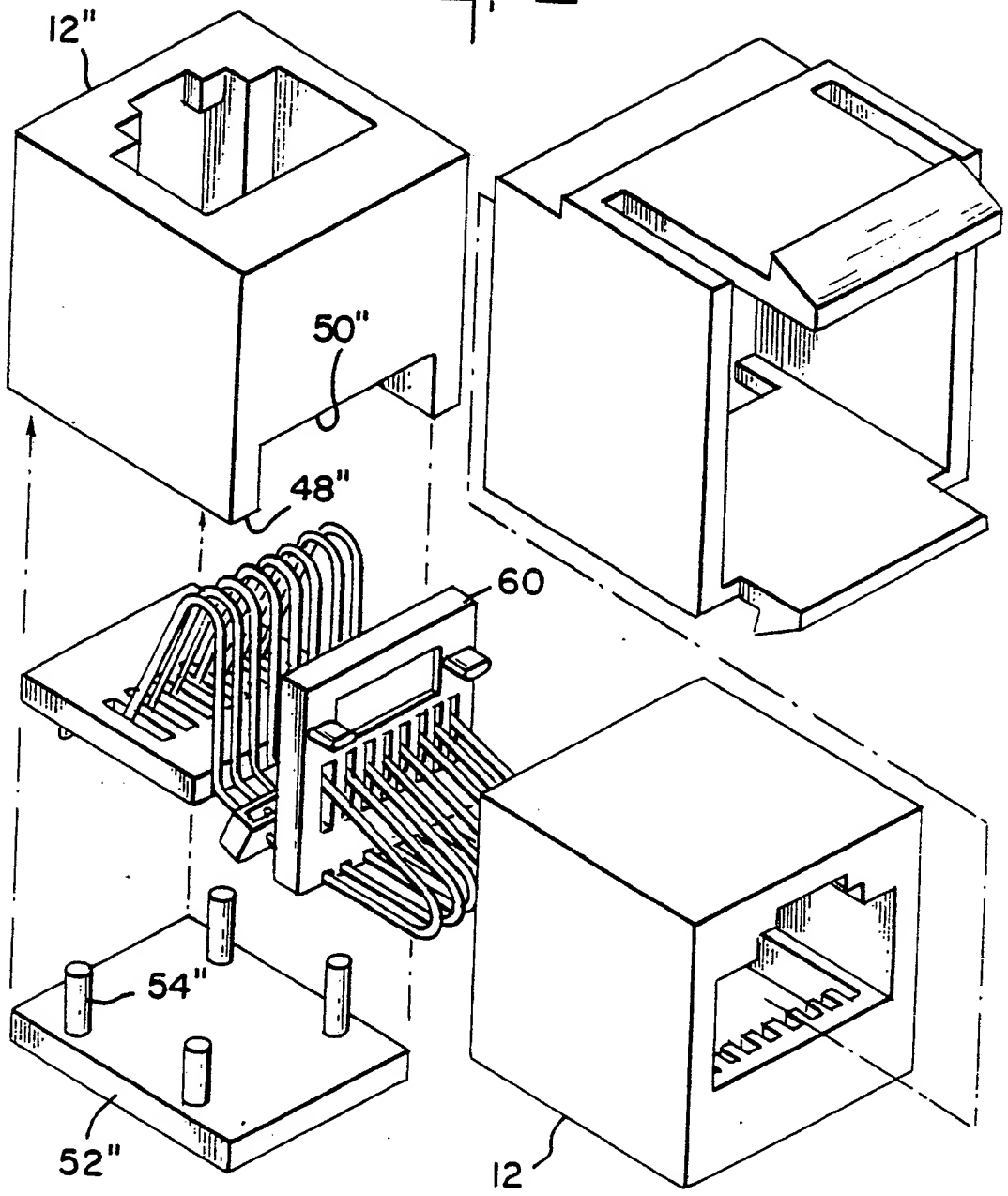
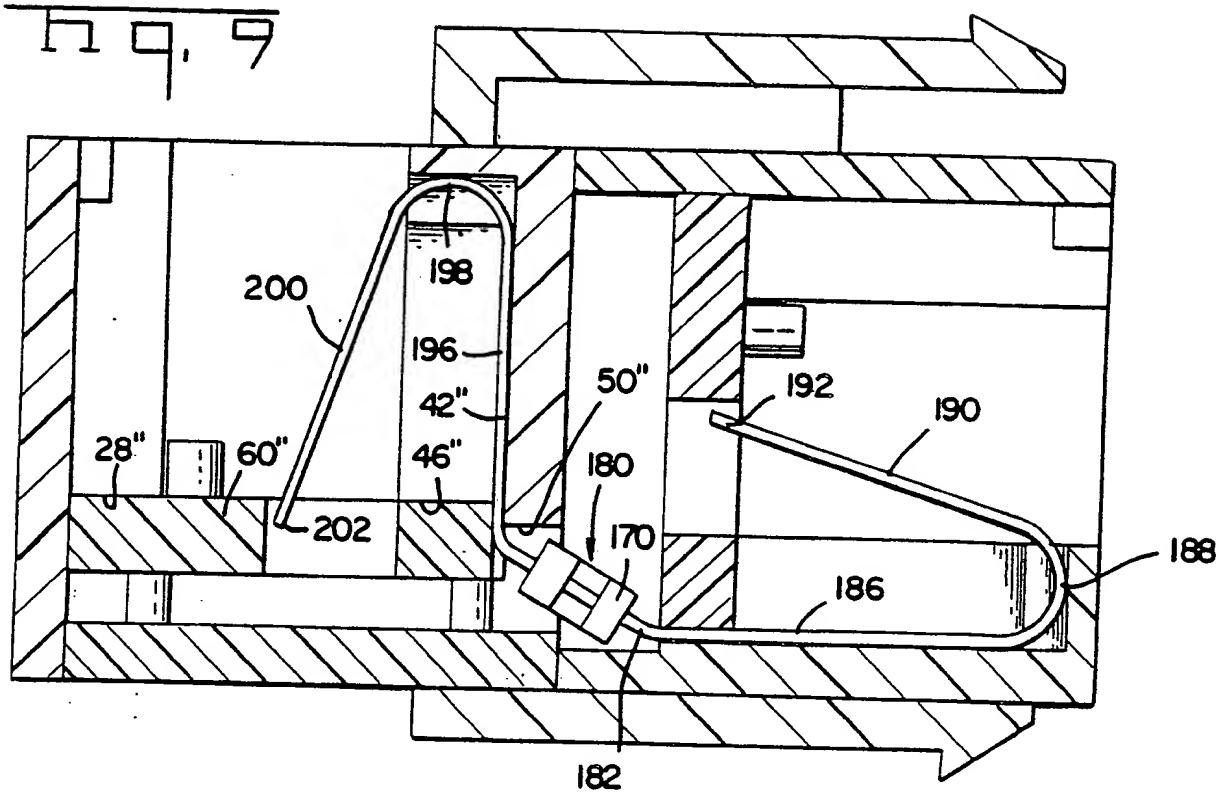


Fig. 9



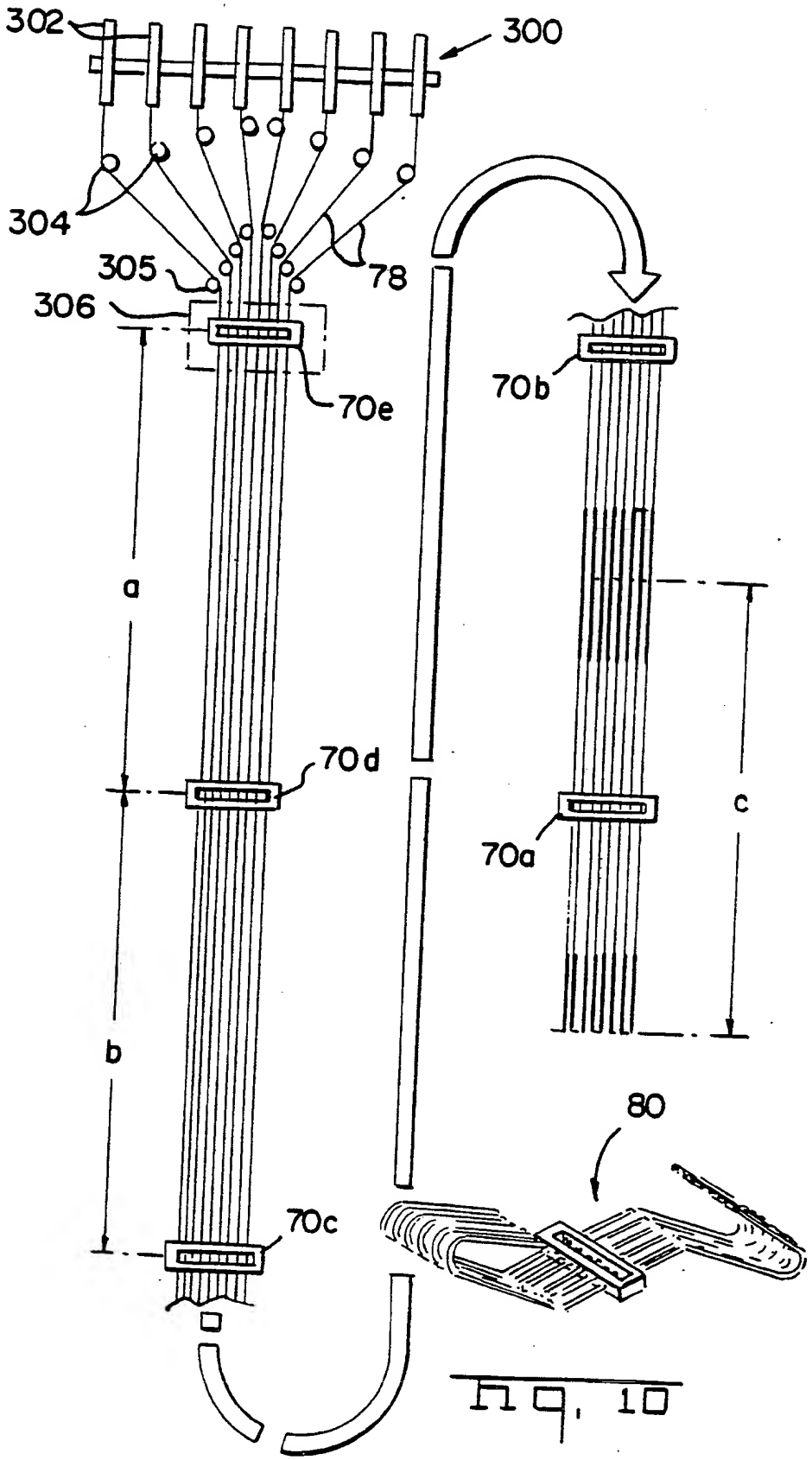


Fig. 10

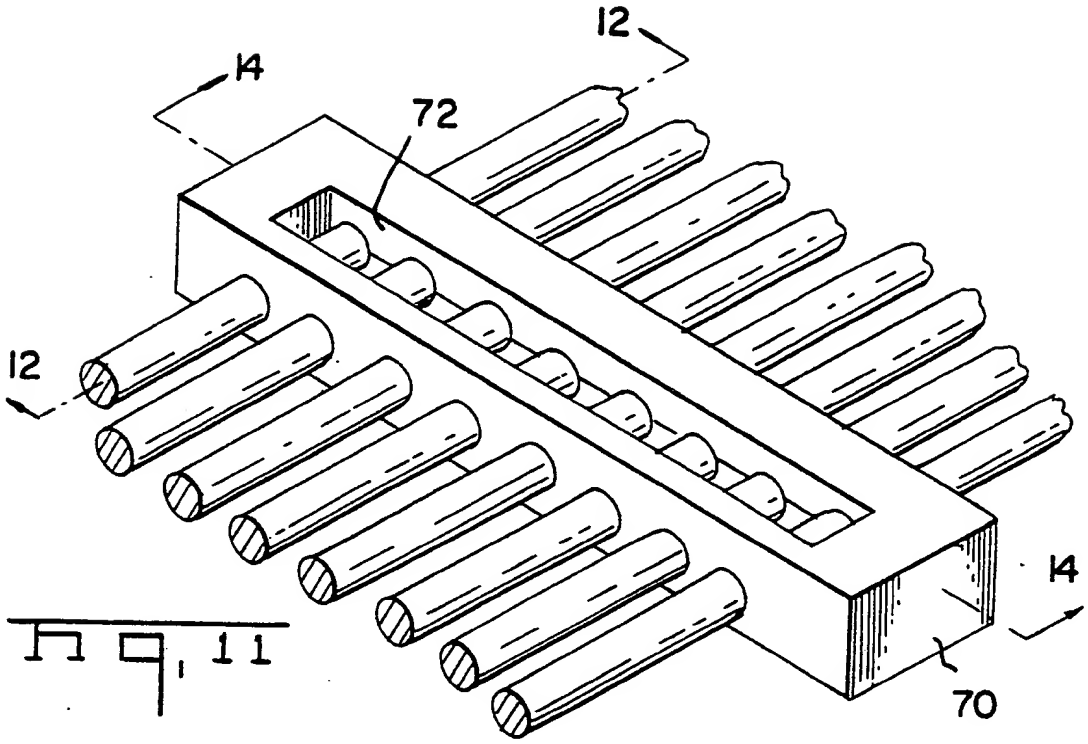


Fig. 11

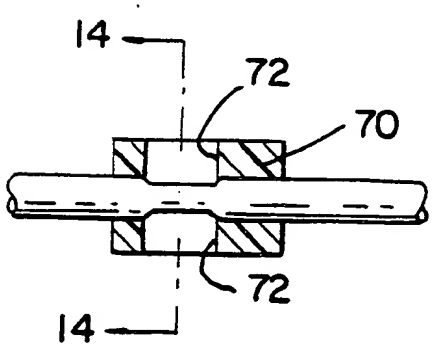


Fig. 12

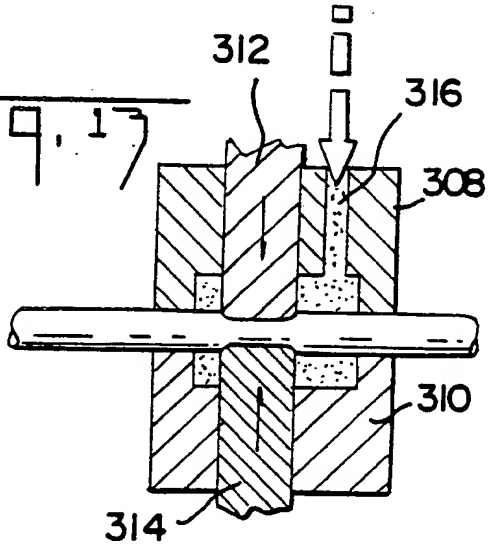


Fig. 13

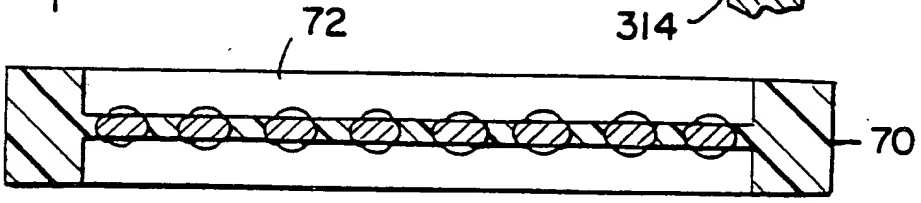


Fig. 14

INTERNATIONAL SEARCH REPORT

International Application No PCT/US 88/02617

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC[4] H 01 R 43/16, 31/00, 13/26

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
IPC[4]	H 01 R

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category *	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
A	US, A, 4444451 (MAYERS R.W.) 24 April 1984 see column 1 line 63 - column 4 line 13	1-10
A	US, A, 4460234 (BOGESE C.E.) 17 July 1984 see column 6 line 64 - column 7 line 2	2,3,8
X	US, A, 4273402 (HUGHES D.W.K.) 16 June 1981 see column 1 line 26 - column 4 line 27	8,9
X	US, A, 4153327 (JOHNSSON D.W,) 8 May 1979 see whole document	8,9
A	US, A, 4268109 (HARDESTY E.C.) 19 May 1981 see column 1 line 45- column 2 line 33	8,9
A	US, A, 4593966 (MEYER D) 10 June 1986 see whole document	8,9

* Special categories of cited documents: [10]

"A" document defining the general state of the art which is not considered to be of particular relevance

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
16th November 1988	09 DEC 1988
International Searching Authority	**Signature of Authorized Officer**
EUROPEAN PATENT OFFICE	P.C.G. VAN DER PUTTEN

Form PCT/ISA/210 (second sheet) (January 1985)

ANNEX TO THE INTERNATIONAL SEARCH REPORT
ON INTERNATIONAL PATENT APPLICATION NO. PCT/US 88/02617
SA 24005

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report.
The members are as contained in the European Patent Office EDP file on
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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US-A- 4444451	24/04/84	US 4438998	27/03/84
US-A- 4460234	17/07/84	None	
US-A- 4273402	16/06/81	EP 0028460 JP 56065473 CA 1127257	13/05/81 03/06/81 06/07/82
US-A- 4153327	08/05/79	None	
US-A- 4268109	19/05/81	EP 0027044 WO 81/01081 ATE 5359	15/04/81 16/04/81 15/12/83
US-A- 4593966	10/06/86	None	